



Basket No.: M&N-IT-553

### CERTIFICATION

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English and German languages, and that I believe that the attached text is a true and complete translation of the application filed on July 3, 2003 under Application No. 10/613,368.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Hollywood, Florida

---

Christine Kahl

September 30, 2003

Lerner & Greenberg, P.A.  
P.O. 2480  
Hollywood, FL 33022-2480  
Tel.: (954) 925-1100  
Fax.: (954) 925-1101



Description

5 Drive device for a light-emitting component

In drive devices for light-emitting components, for example lasers, as is known, detectors (e.g. monitor photodiodes) are present which measure the light power of the light-emitting  
10 component and enable the light power to be regulated.

In monitor photodiodes integrated in laser diodes, various causes give rise to so-called "monitor tracking errors". These "monitor tracking errors" are based on temperature-  
15 dependent inaccuracies or measurement errors of the monitor diode, which should actually measure the coupled-in optical power of the laser diode correctly. In the case of an edge-emitting laser, for example, a "monitor tracking error" may be based on the fact that the optical power at the front mirror  
20 of the laser and the optical power at the rear mirror of the laser are not proportional - in a temperature-dependent manner. In the case of a surface-emitting laser (VCSEL laser), a "monitor tracking error" may also be caused by a mode-selective and thus temperature-dependent coupling between  
25 the laser and its monitor photodiode.

The invention is based on the object of specifying a drive device for a light-emitting component in which fluctuations in the output power of the light-emitting component on account of  
30 measurement errors of the assigned photodetector, in particular on account of "monitor tracking errors", are avoided.

This object is achieved according to the invention by means of a drive device having the features in accordance with patent claim 1. Advantageous refinements of the drive device according to the invention are specified in the subclaims.

5

Accordingly, the invention provides a drive device having a reference source, which generates a power stipulation signal stipulating a desired light power. Moreover, the drive device has a photodetector for measuring the respective actual light  
10 power. A regulating device is connected to the photodetector and to the reference source, said regulating device generating a regulating signal, which regulates the light power, for the light-emitting component. In addition, the drive device according to the invention has a correction device, which  
15 compensates for temperature-dictated measurement errors of the photodetector by modifying, in a temperature-dependent manner, the power stipulation signal generated by the reference source.

20 An essential advantage of the drive device according to the invention is to be seen in the fact that this drive device can be realized with relatively simple and cost-effective components, since only the power stipulation signal generated by the reference source has to be modified in a temperature-  
25 dependent manner in order to compensate for the temperature-dictated measurement errors.

A further essential advantage of the drive device according to the invention is that the hitherto customary components for  
30 light regulation, that is to say the regulating device and the photodetector, can continue to be used unchanged; these components do not have to be modified since, according to the invention, only the desired light power or the power

stipulation signal is changed in a temperature-dependent manner.

5 Digital components are particularly cost-effective, so that it is regarded as advantageous if the correction device is formed at least partly by digital components.

10 In accordance with one advantageous refinement of the drive device, it is provided that the correction device has a memory, correction values for the temperature-dependent modification of the power stipulation signal being stored in said memory.

15 Preferably, the correction device has a control device, which, with a temperature sensor, measures the temperature of the monitor diode or a temperature proportional thereto and then reads from the memory that correction value which is respectively assigned to the measured temperature value.

20 The correction values and the assigned temperature levels or temperature ranges may be stored preferably in table form in the memory. The table may preferably be configured as a "look-up table".

25 The control device of the correction device is preferably formed by a controller module, in particular by a microprocessor.

30 In order to ensure that the temperature response or the compensation regulation can be changed arbitrarily by the user or can be set externally, it is regarded as advantageous if the memory and thus the memory values contained therein are arbitrarily programmable. In such a case, it is possible to compensate for tracking errors with arbitrary temperature

characteristic curves; the compensation can thus be adapted to the optical components respectively used - thus e.g. to the respective laser and the respectively assigned monitor diode.

5 Furthermore, the correction device preferably has a digital-to-analog converter connected downstream of the control device. This digital-to-analog converter (D/A converter) forms an analog modification signal from the correction value read from the memory by the control device or an auxiliary  
10 correction value derived therefrom by the control device, the power stipulation signal of the reference source being modified by means of said modification signal.

In the context of a further advantageous refinement, the  
15 control device has an analog adder, which adds the power stipulation signal of the reference source and the modification signal of the D/A converter. The adder may be formed by an operational amplifier circuit, for example.

20 As has already been explained in the introduction, "monitor tracking" errors occur particularly in the case of laser diodes, so that it is regarded as advantageous if the drive device is used for driving a laser as light-emitting component. The photodetector for detecting the light power of  
25 the laser is then preferably a monitor diode of the laser.

The invention furthermore relates to a method for driving a light-emitting component.

30 In order to be able to carry out such a method without a high outlay and using simple components, the invention provides for a desired light power to be stipulated and for the actual light power to be measured by means of a photodetector, for the light power of the light-emitting component to be

regulated in such a way that the deviation between desired  
light power and the measured actual light power becomes  
minimal, a temperature-dictated measurement error of the  
photodetector being compensated for by virtue of the desired  
5 light power being modified in a temperature-dependent manner.

Advantageous refinements of the method according to the  
invention are specified in the subclaims.

10 With regard to the advantages of the method according to the  
invention and of the advantageous refinements of the method  
according to the invention, reference is made to the  
explanations above in connection with the drive device  
according to the invention.

15

In order to elucidate the invention,

Figure 1 shows an exemplary embodiment of a drive device  
according to the invention, and

20

Figure 2 shows an exemplary embodiment of a correction device  
of the kind that can be used in the drive device according to  
the invention as shown in Figure 1.

25 Figure 1 reveals a drive device 10 for a laser diode 20. The  
drive device 10 has a reference source 30, which generates a  
power stipulation signal UREF1 stipulating a desired light  
power.

30 The drive device 10 furthermore has a monitor diode 40, which  
is suitable as photodetector for measuring the actual light  
power of the laser diode 20.

The monitor diode 40 is connected to an input E50a of a regulating device 50 embodied as a BIAS regulator. The regulating device 50 generates a regulating signal that controls the light power of the laser diode 20 - for example a  
5 laser current  $I_l$  - for the laser 20. Furthermore, the regulating device 50 is connected by its further input E50b to the reference source 30 via a correction device 60.

The task of the correction device 60 is to modify the power  
10 stipulation signal UREF1 of the reference source 30, to be precise in such a way that a temperature-dictated measurement error of the monitor diode 40 is compensated for. For this purpose, the correction device 60 generates a modified power  
15 stipulation signal UREF2 from the power stipulation signal UREF1 stipulated by the reference source 30.

The modified power stipulation signal UREF2 passes to the further input E50b of the regulating device 50 and is processed by the regulating device 50. The task of the  
20 regulating device 50 is to set the laser current  $I_l$  for the laser diode 20, taking account of the modified power stipulation signal UREF2 present on the input side and the actual light power measurement signal  $I_{meas}$  supplied by the monitor diode 40, in such a way that the deviation between the  
25 actual light power and the desired light power stipulated by the modified power stipulation signal UREF2 becomes minimal.

In order to generate the laser current  $I_l$ , the regulating device 50 has an operational amplifier 510, whose "inverting"  
30 input is connected to a variable resistor RBIAS. A voltage which is proportional to the current  $I_{meas}$  flowing through the monitor diode 40 is thus present at the "inverting" input of the operational amplifier 510.

By means of the variable resistor RBIAS, the laser current  $I_l$  can be preset "by hand" or in user-specific fashion.

The "noninverting" input of the operational amplifier 510 is connected to the further input E50b of the regulating device 50 and thus has the modified power stipulation signal UREF2 of the correction device 60 applied to it.

On the output side, the operational amplifier 510 is connected to a base terminal of a transistor whose emitter terminal is grounded and whose collector terminal forms the terminal for the laser diode 20. The output voltage of the operational amplifier 510 is "buffered" by a capacitance CBIAS.

At its input E60, the correction device 60 has an analog adder 600, whose output forms the output A60 of the supervisory device 60. The analog adder 600 is additionally equipped with a control input S600 connected to an output A610 of a digital/analog converter (D/A converter) 610. On the input side, the D/A converter 610 is connected to a control device 620 connected to a temperature sensor 630 and a freely programmable memory (RAM module) 640.

The drive device in accordance with Figure 1 is operated as follows:

The reference source 30 generates the power stipulation signal UREF1 stipulating the desired light power of the laser diode 20. This power stipulation signal UREF1 is modified by the correction device 60, the modified power stipulation signal UREF2 being generated. The modified power stipulation signal UREF2 passes to the regulating device 50, which drives the laser diode 20 by means of the laser current  $I_l$  in such a way



that the laser diode 20 emits a light power corresponding to the modified power stipulation signal UREF2.

5 The light power of the laser diode 20 is measured by means of the monitor diode 40, which forwards a measurement signal Imeas corresponding to the measured actual light power to the regulating device 50. The operational amplifier 510 within the regulating device 50 then readjusts the laser current I1 in such a way that the actual light power measured by the  
10 monitor diode 40 corresponds to the desired light power stipulated by the modified power stipulation signal UREF2.

If the monitor diode 40 were an "ideal" monitor diode having no temperature-dictated measurement error whatsoever, then a  
15 modification of the power stipulation signal UREF1 would be unnecessary. In reality, however, monitor diodes such as the monitor diode 40 have so-called "monitor tracking errors"; these are temperature-dependent measurement errors. On account of these measurement errors, the actual light power  
20 measured by the monitor diode 40 does not correspond to the real actual light power of the laser diode 20. A regulating error of the regulating device 50 thus occurs, so that the laser current I1 is no longer set correctly by the regulating device 50.

25 In order to avoid this temperature-dictated measurement error of the monitor diode 40, the correction device 60 modifies the power stipulation signal UREF1 generated by the reference source 30 to form the modified power stipulation signal UREF2.  
30 This is done as follows:

By means of the temperature sensor 630, the control device 620 measures the temperature respectively prevailing at the monitor diode 40, or a temperature proportional thereto.

Depending on the temperature measurement value  $T$  measured by means of the temperature sensor 630, the control device 620 reads from the memory 640 a correction value ( $K(T)$ ) appropriate for the respective temperature measurement value  $T$ . For this purpose, correction values together with the assigned temperature levels or temperature ranges are stored in table form in the memory 640. This table forms a so-called "look-up table". The look-up table may contain "delta values" for  $n$  different temperature levels, for example, which values modify the original power stipulation signal  $UREF1$  of the reference source 30 "additively" or "subtractively". The "look-up table" may be constructed for example in such a way that the memory addresses of the memory cells of the memory 640 in each case correspond to a temperature or a temperature measurement value  $T$ ; the content of the memory cells then specifies the assigned correction value  $K(T)$ . The number of temperature levels results from the number of memory cells implemented and thus from the number of available address bits (e.g. 128 memory cells given 7 bits).

Once the control device 620 has read the correction value  $K(T)$  associated with the respective temperature measurement value  $T$  from the memory 640, it transfers said correction value to the D/A converter 610. The D/A converter 610 generates from this an analog modification signal  $I_{mod}$  and transfers the latter to the analog adder 600. The analog adder 600 uses the analog modification signal  $I_{mod}$  to generate the modified power stipulation signal  $UREF2$  from the power stipulation signal  $UREF1$  present on the input side by means of addition.

The functioning of the analog adder 600 is illustrated in detail in Figure 2. Figure 2 reveals the reference source 30 connected to an input  $E600$  of the analog adder 600. Also shown is the D/A converter 610, which is connected to the

control input S600 of the analog adder 600 and feeds in the modification signal I<sub>mod</sub>.

5 The analog adder 600 has an operational amplifier 610, whose "noninverting" input is connected to the reference source 30. The output of the operational amplifier 610 is connected to the "inverting" input of the operational amplifier and, in addition, to one terminal of a resistor R, the other terminal of which forms the output of the adder and thus the output A60  
10 of the correction device 60. A current source 620 is additionally connected to the other terminal of the resistor R, said current source generating a current I<sub>mod</sub>' corresponding to the analog modification signal I<sub>mod</sub> of the D/A converter 610.

15 A positive or negative analog modification signal I<sub>mod</sub> generates a positive or negative current flow I<sub>mod</sub>' through the current source 620 and thus a voltage drop U<sub>REF2</sub>-U<sub>REF1</sub> across the resistor R. This "positive" or "negative" voltage  
20 drop - depending on the direction of the current I<sub>mod</sub>' - is added to the reference voltage U<sub>REF1</sub>. In other words, the modified power stipulation signal U<sub>REF2</sub> results in accordance with:

25 
$$U_{REF2} = U_{REF1} + I_{mod}' * R$$

where the current direction of the current I<sub>mod</sub>' depends on the respective sign of the analog modification signal I<sub>mod</sub> of the digital-to-analog converter 610.

30

List of reference symbols

10	Drive device
20	Laser diode
30	Reference source
40	Monitor diode
50	Regulating device
60	Correction device
510	Operational amplifier
600	Analog adder
610	Digital-to-analog converter
620	Control device
630	Temperature sensor
640	Memory
$I_l$	Laser current
$I_{meas}$	Measurement current of the monitor diode 40
$I_l$	Laser current
$I_{mod}$	Modification signal
$I_{mod}'$	Current
CBIAS	Capacitance
RBIAS	Variable resistor
UREF1	Power stipulation signal
UREF2	Modified power stipulation signal
$K(T)$	Correction value